representative sample of fish from other streams in the United States.

Table 3.26 shows heavy metals concentrations found in fish during the 1997-1998 sampling of the river compared to EPA's *Fish Advisory Screening Values* (EPA 1999). Arsenic, mercury, and selenium had screening values. Concentrations of the three metals were well below corresponding screening values as shown in the table.

No fish with lesions or open sores were observed during the 1997-1998 sampling. The OST Water Resources Department consulted with SDGF&P to determine the origin of lesions and sores seen earlier. In an appendix to the OST Report (Appendix Y in this EIS), Rick Cordes, Fish Health Specialist for SDGF&P, stated:

> The small raised ulcers, 3-5 mm [millimeters] in diameter, some hemorrhagic, were the attachment sites of small leeches, *Myzobdella moorei*, in the family, Piscolidae. These leeches were observed, September 26th, attached to the fins on the catfish sampled. The leeches on the body were most likely causing irritation and were simply dislodged from the catfish by rubbing their skin on the river bottom substrate. The leeches observed on the fins are more difficult to dislodge. Bacterial infections at the sites where leeches were attached are causing the lesions. The bacteria isolated from the kidney and liver are fairly common and may damage internal organs if water quality is poor or the fish cannot cope with the number of leeches attached and the associated secondary bacterial infections. The leeches are opportunistic parasites and maybe more numerous in the Redshirt [sic] area because of the discharge from the water treatment plant. The bacteria are easily killed in properly cooked fish and are usually nonpathogenic to humans. I do not believe that the lesions observed are the result of contaminants entering the river. (11)

Analysis indicates there may be low DO at times in the river near Red Shirt (see Table 3.10). Causes of the low DO have not been determined, but an OST consultant suggested sewage from the Red Shirt water treatment plant (Hoof 1998, Appendix 5, p. 2). In fish already stressed from leeches and associated infections, the added stress of low DO could cause further fish health concerns or fish mortality.

Details of the fish tissue analysis can be found Appendix Q.

WILDLIFE

Comments from the public were received about effects of the alternatives on wildlife and wildlife habitat.

The Angostura area is relatively diverse in habitat and thus in wildlife species, located as it is in the transition zone between ponderosa pine woodlands of the Black Hills and mixed-grass prairie of the Northern Plains (see Attachments 2 and 3 for Angostura-area plant and wildlife species, respectively). Irrigated District croplands within juniper uplands and mixed-grass prairie lie next to the Cheyenne River downstream of the dam. Riparian habitat—more diverse in plant and animal species than surrounding habitat—provides an important connection between aquatic and upland habitat.

Analysis of wildlife impacts focused on prairie woodlands (cottonwoods) and associated bird species for several reasons:

- Prairie woodlands habitat is the main area influenced by regulation of river flows
- Other wildlife species like small and large mammals are not as affected by regulation of flows as are bird species
- Data are readily available for the northern Great Plains and can be applied to the Cheyenne River.

Prairie woodlands contribute to bio-diversity of the semiarid grasslands of the northern Great Plains. Prairie woodlands are riparian or riparian-like habitat (Boldt et al. 1978; Uresk and Boldt 1986) restricted to areas of more moisture, such as north-facing slopes or drainages (Girard et al. 1989). Prairie woodlands provide habitat for many bird species on the northern Great Plains (Emmerich and Vohs 1982; Faanes 1984; Sieg 1991). Greater density of vegetation and layering of the vegetative understory, typical of prairie woodlands, increases species richness and density of passerine birds (Willson 1974; Roth 1976; Rotenberry and Weins 1980). Mature woodlands are essential to sustaining populations of some bird species in the northern Great Plains.

For this analysis, changes in woodland types from cottonwood to green ash or grassland/shrub and changes in bird species diversity were used as indicators of effects from changes in river flows.

Cottonwoods

Cottonwood riparian woodlands are important to bio-diversity. Generally declining along major rivers in the plains region, these woodlands will probably decrease in abundance and distribution in the future, while green ash woodlands increase (Johnson et al. 1976; Johnson 1992).

Many cottonwood sites in a study on the Missouri River showed green ash in the understory (if undisturbed) eventually dominating the woodland community (Mark Rumble, 1998: personal communication). Most cottonwood riparian woodlands in this study consisted of mature trees. The flooding necessary for regeneration of cottonwood riparian woodlands restricts early seral stages (young trees) to narrow bands next to the Missouri River and its tributaries.

Along the Cheyenne River, cottonwoods (*Populas deltoides*) live for about 100-150 years. Currently, cottonwood riaprian woodlands in the area are a mixture of late seral and late-intermediate seral (old trees), with a grass/shrub understory. These trees are about 50-60 years old, established by field transects by Reclamation, the OST, and USFS (U.S. Forest Service) using the USFS' draft *Cottonwood Model* to determine age classification. Transects were also run above Angostura, where cottonwoods were found to be the same age as those below the reservoir.

Grazing occurs throughout the area, managed by Federal agencies (Reclamation controls grazing on lands surrounding the reservoir) and by private land owners. Livestock use cottonwood riparian woodlands for forage and shade and to avoid flies (Uresk 1982; Bjusstad and Girard 1984). In many cases, livestock have destroyed the understory, leading to degradation and loss of this habitat type (Severson and Boldt 1977). Degradation of woodlands from livestock use also reduces bird abundance (Hodorff et al. 1988).

Bird Species

Bird species found in the cottonwood woodlands in the Angostura area were classified as tree, cavity, shrub, and ground nesters for this analysis (Table 3.27). These species are highly dependent on late seral stage prairie woodlands. Because birds differ in environmental

Table 3.27: Bird Species in Old Age Cottonwoods in the Area

Cavity Nesting Birds	Tree Nesting Birds	Shrub Nesting Birds	Ground Nesting Birds
Downy woodpecker	Mourning dove	Brown thrasher	Common yellowthroat
Red-headed woodpecker	Western kingbird	Bell's vireo	Vesper sparrow
Northern flicker	Eastern kingbird	Yellow warbler	Lark sparrow
Black-capped chickadee	Blue jay	Indigo bunting	
House wren	American robin	Rufous-sided towhee	
	Warbling vireo		
	Blackheaded grosbeak		
	Common grackle		
	Orchard oriole		
	Northern oriole		
	American goldfinch		

Source: Mark Rumble, 1998: personal communication.

requirements, their populations can be used as an indicator of environmental conditions in the area (Martin and Finch 1995). Presence of bird species associated with riparian woodlands, for instance, indicates the composition and structure of these woodlands (Mosconi and Hutto 1982). Other wildlife, such as small and large mammals, are less dependent on riparian woodlands in comparison to passerine birds (Faanes 1984; Sieg 1991).

THREATENED OR ENDANGERED SPECIES

This section of the EIS introduces the biological assessment required under Section 7c of the Endangered Species Act. The assessment's purpose is to:

1. Assure that compliance with the Act is incorporated into early planning decisions and alternative selection

2. Establish and promote interagency cooperation and consultation in project decision making which may affect listed and candidate species

3. Develop possible conservation and mitigation measures to avoid or reduce identified impacts.

The USFWS (as required under the Act) provided a list of endangered, threatened, and candidate species that are or may be present in the area from the reservoir to the confluence of the Belle Fourche and Cheyenne Rivers (Table 3.28). Information for the table came from Ashton and Dowd (1991). The SDGF&P provided a list of species of special status (Table 3.28), which included eight species on the USFWS list. Protection of rare species in the area is also undertaken by the South Dakota Natural Heritage Program, a cooperative project of The Nature Conservancy and SDGF&P. This program documents and monitors the rarity and

Table 3.28: Endangered or Threatened Species and Species of Special Status

Species	Scientific Name	Federal Status	State Status
Bald Eagle	*Heliaeetus leucocephalus*	Threatened	Endangered
Whooping Crane	*Grus americana*	Endangered	Endangered
Piping Plover	*Charadrius melodus*	Threatened	Threatened
Interior Least Tern	*Sterna antillarum athalassos*	Endangered	Endangered
Black-footed Ferret	*Mustela nigripes*	Endangered	Endangered
Mountain Plover	*Charadrius montanus*	Proposed	
American Burying Beetle	*Nicrophorus americanus*	Endangered	Endangered
Swift Fox	*Vulpes velox*	Candidate	Threatened
Black-tailed Prairie Dog	*Cynomys ludovcianus*	Candidate	Pest
Sicklefin Chub	*Hybopsis meeki*	Candidate	Threatened
Sturgeon Chub	*Hybopsis gelida*	Candidate	Threatened
Plains Topminnow	*Fundulus sciadicus*		Threatened
Finescale Dace	*Phoxinus neogaeus*		Endangered
American Peregrine Falcon	*Falco peregrinus anatum*		Endangered
Fringe-tailed Myotis	*Myotis thysanodes pahasapensis*		Rare
Marten	*Martes americana*		Rare
Black Bear	*Ursus americanus*		Rare
Mountain Lion	*Felis concolor*		Rare
Long-nose Sucker	*Catostomus catostomus*		Threatened
Banded Killifish	*Fundulus diaphanus*		Endangered
Osprey	*Pandion haliaetus*		Threatened
Baird's Sparrow	*Ammodramus bairdii*		Rare
Spiny Softshell	*Apalone spinifera*		Threatened
Short-horned Lizard	*Phrynosomoa douglasi*		Rare
Regal Fritillary	*Speyeria idalia*		Rare
Ottoe Skipper	*Hesperia ottoe*		Rare
Great Blue Heron	*Ardea herodias*		Rare

Common Merganser	*Mergus mergnaser*		Rare
Golden Eagle	*Aquilla chrysaetos*		Rare
Barn Owl	*Tyto alba*		Rare
Burrowing Owl	*Speotyto cunicularia*		Rare
Brewer's Sparrow	*Spizella breweri*		Rare
Quillback	*Carpiodes cyprinus*		Rare
Plains Spotted Skink	*Spilogale putorius interrupta*		Rare
Tiger Beetle	*Amblychila cylindriformis*		Rare
Lareflower Townsend Daisy	*Townsendia grandiflora*		Rare
Bitter Fleabane	*Erigeron acris*		Rare
Barr's Milkvetch	*Astragalus barii*		Rare

possible threat to continued survival of about 400 species, as well as a number of unique natural features and plant communities.

Bald Eagle

The bald eagle was reclassified from endangered to threatened in the lower 48 states in 1995. It has recently been proposed for de-listing. South Dakota lists them as endangered. By restricting DDT, increased protection, and reintroduction, breeding pairs have increased dramatically over the years. Eagles may pass through any part of the State during migration, and they winter near open water where large trees provide roosting sites. A single active nest was reported along the Missouri River below Fort Randall in 1990, the first confirmed successful bald eagle nest in South Dakota since 1885. This same nest also was successful in 1991.

Nesting activity and success have increased recently. The USFWS in 1998 documented 14 active nests in the State, all but one located along the Missouri River between Fort Randall and Sioux City, along the James River in eastern South Dakota, and near Sisseton in the northeast corner of the State. Other nests have been reported east of the Missouri but have not been confirmed. The only confirmed active nest west of the Missouri is on the Belle Fourche River at the Meade-Butte County border. This nest was active 1997-1999. Two other nests were reported in the Black Hills but have not been confirmed (Jay Peterson, 1999: personal communication).

Although wintering eagles depend primarily on fish, they are opportunistic feeders and their diet varies by region. Thus, rabbits and waterfowl, as well as carrion, are also taken. Wintering eagles are associated with unfrozen lake, river, and wetland habitat. Distribution depends on prey density, suitable perch and roost sites, weather conditions, and freedom from human disturbance. Their numbers normally fluctuate at particular wintering areas. Dams have caused changes in winter bald eagle distribution, concentrating populations by providing forage places below the dams. The presence of a fishery, however, does not necessarily mean eagles will be attracted to the area.

Whooping Crane

The whooping crane has been listed as endangered by both USFWS and SDGF&P. Most sightings occur in April-May and September-October and are within a north-south corridor 100 miles east and 150 miles west of Pierre. The Angostura area is within the migration corridor used by the Wood Buffalo-Aransas population. Single cranes, cranes in pairs, family groups, and small flocks use areas in South Dakota as nontraditional stopover sites on the annual migration. Suitable sites include cropland and pastures, wet meadows, shallow marshes, shallow parts of rivers and reservoirs, and alkaline basins. Sites are used opportunistically, usually for short periods like overnight or for several days if inclement weather is encountered (Armbruster 1990). Habitat characteristics vary but usually include shallow water, gently sloping shoreline, and no human activity.

Cranes are relatively long-lived, reaching 22-24 years in the wild. Breeding may begin at age three, but more typically at four. Although two eggs are typically laid, rarely do both survive to fledge. Cranes are opportunistic feeders during migration, readily exploiting any suitable plant or animal food item they encounter, including cultivated grains like barley, corn, sorghum, and wheat (Armbruster 1990). Feeding occurs in both uplands and wetlands.

Piping Plover

The piping plover was listed in 1985 as threatened by USFWS in all of its range outside the Great Lakes (where it's listed as endangered). It is listed as threatened by SDGF&P. Reproductive success is generally low, and successful breeding pairs usually fledge only one chick. Plover numbers declined over much of their range as a result of habitat destruction, unstable water levels, and human disturbance of nesting adults and chicks. Rising water levels are a major cause of nest and chick losses. There is one nesting record for Angostura Reservoir (Nell McPhillips, 1997: personal communication). Plovers occur in the State as late spring and early summer residents, generally from late April-August.

Nests are located on sparsely vegetated islands, sandbars, and shorelines on the higher parts of beaches away from the waterline and vegetation. Nests—shallow, scraped depressions, sometimes lined with small pebbles, shells, or other debris —frequently are found in association with least tern nests (Federal Register 1985). The female plover lays four eggs after which both parents share in incubation lasting about 28 days. Chicks leave the nest shortly after hatching but continue to be tended by both parents for about 30 days until they are able to fly (U.S. Fish and Wildlife Service 1988). Until they fledge, young remain within 400-500 feet of the nest (Johnsgard 1979). Fledging is usually completed by mid-late August.

Food habits are not well known (Corn and Armbruster 1993). Small invertebrates such as terrestrial worms, crustaceans, mollusks, and insects found at or near the water's edge are taken as food (U.S. Fish and Wildlife Service 1988).

Interior Least Tern

The interior least tern was listed by USFWS as endangered through most of its past range in 1985 (it is also listed as endangered by SDGF&P). The breeding population has been reduced to a remnant due to human disturbance during nesting (U.S. Fish and Wildlife Service 1988) and habitat degradation from the effect of dams, channeling, and diversion on river flows. Parts of the Missouri River in South Dakota, Nebraska, and Missouri have lost 99% of the nesting sites available at the turn of the century (Federal Register 1985). The only areas where

the tern is still known to breed are on sand bars along the Cheyenne River, around Lake Oahe, and along the Missouri River in the southeast part of the South Dakota.

Nests are generally found on flat, open sand or pebble beaches within or very close to the floodplain of large rivers, lakes, and reservoirs. Nests are usually barren except for scattered clumps of vegetation, and are often next to shallow pools, riffles, and river backwaters offering abundant small fish populations (U.S. Fish and Wildlife Service 1988). Breeding colonies usually are comprised by up to 20 nests spaced far apart (Johnsgard 1979; Federal Register 1985). Terns frequently are found in conjunction with piping plovers (U.S. Fish and Wildlife Service 1988). Females lay 1-4 eggs and both parents incubate (U.S. Fish and Wildlife Service 1988).

The tern feeds almost exclusively on small fish, but they have also been known to eat crustaceans and insects. They will travel up to two miles from their nest sites in search of food (U.S. Bureau of Reclamation 1988).

Black-footed Ferret

The black-footed ferret was listed in 1964 as endangered by USFWS, and is similarly listed by SDGF&P. A mink-sized member of the weasel family, the ferret measures 18 inches long and weighs 2.5 pounds. It has a black mask, black feet and a black-tipped tail, with back and sides of tan or yellow, an underside of white or cream. Although never abundant, their range once extended across nearly 100 million acres in 12 states and 2 Canadian provinces (Clark 1989). The ferret became endangered following destruction of habitat and prey-base by poisoning prairie dogs over the past 70 years (Clark 1989). The last confirmed sighting of a black-footed ferret in South Dakota was in Fall River County in 1983.

The nocturnal secretive ferrets are most often seen in late summer and early fall. Tracks are practically identical to those of mink, but ferrets dig a long, narrow furrow or trench section directly out of a prairie dog burrow. Besides characteristic trenching, ferrets also show their presence by burrows which prairie dogs are suspected to plug as a defense. Ferret habitat includes open grassland, steppe, and shrub steppe areas. They are almost always associated with prairie dogs, living in prairie dog towns, raising their 2-5 young in prairie dog dens, and preying almost exclusively on the rodents. They have also been known to take mice, rats, ground squirrels, rabbits, and various birds, reptiles, and insects (Fagerstone 1987).

The ferret was thought to be extinct until a wild population was discovered near Meeteetse, Wyoming, in 1981. During 1985-1987, the remaining 18 black-footed ferrets of this population were captured (Federal Register 1993). By 1993, the population of ferrets had increased to 300 and was divided into 7 captive populations (Federal Register 1993). They were released in Shirley Basin/Medicine Bow, Wyoming, in 1991, and in the Charles M. Russell National Wildlife Refuge, Montana, and in South Dakota in 1994.

Ferrets have been released at Badlands National Park and Buffalo Gap National Grasslands, with a goal of establishing 100 breeding animals (Doug Albertson, 1999: personal communication), which would sustain the local population. A total of 328 ferrets has been released to date at the two sites, with another release planned for 1999. Surveys in March 1999 counted 22 ferrets in Badlands National Park and 125 ferrets in the Buffalo Gap National Grasslands. Two naturally reproduced litters were observed in 1995, five in 1996, five in 1997, and 24 litters in 1998. It is anticipated that the 1999 survey will show that the 100 breeding ferret goal has been met.

Mountain Plover

The USFWS proposes to list the mountain plover as a threatened species (Federal Register 1999). At the turn of the century, declining numbers were attributed to market hunting. Hunting of the birds was abolished in 1916, but numbers continue to fall due to conversion of prairie to agricultural land, range management practices leaving vegetation too tall, urban sprawl (primarily on wintering grounds), and the continued extermination of prairie dogs. Plovers are also vulnerable to human and vehicular disturbance during courtship, nesting, and brood rearing. Adults have been known to abandon eggs when disturbed. Pesticide use may also pose a threat through direct toxicity to mountain plovers or by reducing food supplies.

The plover is a bird of shortgrass prairie and shrub-steppe landscapes both for breeding and wintering. Breeding occurs in the Rocky Mountain States and Canada south to Mexico, with most breeding birds found in Montana and Colorado. Most wintering birds can be found on grasslands or similar landscapes in California, with fewer birds wintering in Arizona, Texas, and Mexico. The plover is thought to be eliminated from South Dakota.

The plover evolved on grasslands inhabited by large numbers of nomadic grazing ungulates—bison, elk, and pronghorn—and burrowing mammals—kangaroo rats, badgers, and prairie dogs. Herbivores dominated the prairie landscape and their grazing, wallowing, and burrowing maintained a mosaic of vegetation and bare ground to which the plover became adapted. Unlike other plovers, mountain plovers are rarely found near water. Short vegetation, bare ground, and flat topography are recognized as habitat-defining characteristics for both breeding and wintering locales (Federal Register 1999).

In many areas, mountain plovers are closely associated with prairie dog towns, but tilled fields also serve as habitat. Use of fields almost assures breeding failure, as nests are destroyed by farming operations or abandoned once crops become too tall.

Plovers arrive on the breeding grounds by late March. The nest is a simple scrape on the ground lined with organic debris, typically with area vegetation less than 4 inches high, at least 30% bare ground, and with a conspicuous object such as a cow chip, clump of vegetation, or a rock nearby (Knopf and Miller 1994). Taller vegetation in the area to shade chicks and adult birds is also necessary. Nest sites occur on ground with less than 5% slope. They usually lay three well-camouflaged eggs. Only one adult attends the nest during the 29-day incubation period. Some evidence suggests a female produces one clutch of eggs for her mate to attend, and then produces a second clutch about two weeks later which she attends herself. The brown-speckled chicks reach adult size 35 days after hatching. Flocks of plovers begin to form as early as mid-June and increase in size until mid-August. Migration occurs between August and October.

Plovers feed primarily on insects. The type of prey changes throughout the season as one type of insect or another becomes more prevalent. The mountain plover can thrive without drinking freestanding water as it obtains sufficient water from its food.

American Burying Beetle

The American burying beetle (also known as the giant carrion beetle) was listed by USFWS as endangered in 1989 and is similarly listed by SDGF&P. The beetle, up to 1.4 inches long, was once widely distributed throughout North America, having been reported in 32 states and 3 Canadian Provinces (Houtcooper et al. 1985; USFWS 1988; Federal Register 1989). There are records of the beetles in Gregory and Tripp counties in eastern South Dakota, and recent

surveys found them in Haakon and Bennett counties. For reasons unknown, however, the beetle is no longer found throughout most of its original range.

Habitat has not been clearly defined: Although virgin or primary forest has been suggested as preferred habitat, several beetles captured in the Midwest after 1960 were in mixed agricultural lands—including pastures and mowed fields—and ordinary second-growth woods. Current distribution, as outlined by captured beetles, suggests it can also occur in grasslands habitat.

While beetles have been seen consuming live insects (U.S. Fish and Wildlife Service 1988), generally they locate a dead animal, excavate underneath, and then bury the carcass. The buried carcass serves as food for the beetles' larvae. Coated with secretions that slow decomposition, the carcass is essentially preserved in a semi-mummified state (White 1983). The female lays eggs in an adjoining tunnel. Larvae are fed regurgitated pabulum until they are ready to pupate (Milne and Milne 1980). Occasionally, two broods of young are produced, but the young do not reproduce until the following June or July. Adults are believed to overwinter singly in the soil (Federal Register 1989).

Swift Fox

The swift fox is listed by USFWS as a candidate species, while SDGF&P lists it as threatened, noting that occurrence is "critically rare" and that its habitat continues to be seriously threatened (Houtcooper et al. 1985). It is 27-34 inches long and weighs about 4-6 pounds, about the size of a large house cat. Pale buff with a white underside, the fox has characteristic large triangular ears, dark spots on the muzzle below the eyes, and a black-tipped, bushy tail.

The fox was once abundant on the North American prairie from Canada to the Texas panhandle (Federal Register 1995). It was found throughout South Dakota. By 1900, however, the fox was eliminated from the northern parts of its range (Scott-Brown et al. 1987). No sightings were reported in the State from 1914-1966 (Scott-Brown et al. 1987), although there have been sightings since then. Based on current distribution, the USFWS estimates the fox is gone from 80-90% of its past range. Remaining populations are found in scattered, isolated pockets of remnant short-mid grass prairie habitat. Loss of prairie to agriculture and mining, recurring drought in the Midwest, and prairie dog control have reduced habitat and prey for the fox. It is also easily trapped and readily takes poison bait intended for coyotes and red fox (Federal Register 1995).

The fox now appears to be well established in eastern Colorado, western Kansas, eastern New Mexico, and eastern Wyoming. Smaller populations can be found in western Nebraska, southwest South Dakota, and the Texas panhandle. It has been reintroduced in Canada, where a captive breeding program has met with success.

Unlike coyotes and other foxes, the swift fox uses dens year-round. It may excavate its den near hilltops, in a sandy stream valley, along a fence row, roadside ditches, level pastures, and—when favorable sites are not available—in cultivated fields (Scott-Brown et al. 1987). They may also occupy abandoned badger dens or prairie dog burrows. The fox breeds in early spring, producing 4-5 pups (ranging from 1-8) 51 days later. Pups emerge from the den in a month and are weaned at 6-7 weeks. Parents may move the pups several times. The pups disperse from the den during late summer. Normally a nocturnal hunter, the fox is an opportunistic predator, feeding on small mammals, birds, insects, reptiles, vegetation, and carrion.

Black-tailed Prairie Dog

The black-tailed prairie dog was listed by USFWS as a candidate species in 1999, while the State lists it as a pest. Black-tailed prairie dogs are stout, burrowing animals, about 14-17 inches long and weighing about 1-3 pounds. They are generally yellowish in color, slightly lighter on the belly, with short ears and a short black-tipped tail. Conversion of prairie to farmland in the eastern part of their range between 1890-1930, repeated poisonings from 1920-1970, and sylvatic plague (which results in near 100% mortality in a colony) has reduced the number of black-tailed prairie dogs and the size and number of colonies.
Black-tailed prairie dogs were one of the most conspicuous and characteristic residents of the short- and mixed-grass prairies of the United States. It is estimated that they once numbered 5,000,000,000, occupying over 100,000,000 acres. Today, black-tailed prairie dogs occupy about 1,000,000 acres within their original range. While complexes of more than 10,000 acres still exist, most colonies are small—typically less than 100 acres—disjunct, and geographically isolated from the others. They occupy between 150,000-250,000 acres in South Dakota, with a stable to expanding population. Four of the seven relatively large complexes (greater than 10,000 acres each) remaining in North America are in the State. Black-tailed prairie dogs occupy one colony of about 50 acres in the Angostura area, just west of the dam.

Within the colonies, black-tailed prairie dogs live in contiguous, territorial family units called coteries. Female black-tailed prairie dogs do not breed until their second year and usually live 3- 5 years. They produce a single litter annually, usually of 4-5 pups. Migration is limited to about three miles. Black-tailed prairie dogs dispersing from their home colonies usually move into other established colonies rather than attempting to start a new colony.

Sicklefin Chub

The sicklefin chub is also listed by USFWS as a candidate species. The SDGF&P lists it as threatened, noting that it is "critically rare in the State and that its habitat has been greatly reduced by main stem impoundments" (Houtcooper et al. 1985). The chub grows to a maximum length 4 inches. It is extremely rare throughout much of its range, habitat having been destroyed by dams and canals. It is adapted to large, turbid rivers with strong currents over a bottom of sand or fine gravel (Pflieger 1975). In South Dakota, the chub has only been known to occur in the Missouri. Suitable habitat also can be found in the Cheyenne River.

Young chub have been collected from the Missouri in July, suggesting a spring spawning season. It is believed to be a bottom-feeder (Pflieger 1975).

Sturgeon Chub

The sturgeon chub is also listed by USFWS as candidate species. The SDGF&P lists it as threatened, noting that it is "critically rare in the State and. . . its habitat is rare and seriously threatened" (Houtcooper et al. 1985). The fish are mottled olive green-brown on back and have a silvery-cream underside, with characteristic small *keels* or ridges of skin on each scale of their upper body. Keels are believed to help the chub maintain position in fast currents. These keels identify the chub from the very similar longnose dace. Reaching a maximum of 4 inches long, chub have small eyes and a long fleshy snout overhanging the mouth. Dense concentrations of tiny external taste buds can be found on the lower head, body, and fins.

The chub originally could be found in the Missouri River drainage from Montana to the confluence with the Mississippi River and from the Mississippi drainage to the mouth of the

Ohio River. In South Dakota, the chub has been found in the Missouri, White, Grand, Little Missouri, and Cheyenne Rivers. It remains extremely rare throughout most of its range, though, its habitat having been destroyed by dams and channelization (Pflieger 1975).

The chub is well equipped for life in continuously turbid water (Pflieger 1975) over sand or gravel areas where the current is swift (Brown 1971; Pflieger 1975).

The oldest recorded sturgeon chub was 4 years old; less than 5%, however, live 3 years. It matures its second year. Spawning occurs in the spring and early summer at water temperatures of 65-72º F. Fish ready to spawn (ripe) have been collected from early June until the end of July. About 15-20% of a ripe female's body weight is composed of eggs. No detailed studies have been done on feeding, but chub are believed to be bottom-feeders. Stomachs of collected fish have contained unidentified insect parts. The chub may be preyed upon by walleye, sauger, pike, and burbot.

SOCIAL AND ECONOMIC CONDITIONS

Comments from the public focused on social and economic effects of the alternatives on irrigators, the counties, the State, Pine Ridge Reservation, and the region. The Angostura Unit generates income and employment by expenditures for crop production, farm income, and recreation-related goods and services, directly affecting economic conditions in the area. Changes in water management could indirectly affect communities and lifestyles in the area, so a social analysis was done based on the regional economic analysis, focusing on changes in agriculture and recreation brought on by changes in operation of the reservoir.

After a discussion of methods, this section is made up of two parts: The first covers population characteristics and the economy of Fall River and Custer counties. These counties contain most (if not all) of the Angostura Unit and the District, and most of the effects would be felt in this area. Since the Reservation is distinct from the counties in both population characteristics and economy, it has been accorded a section of its own. The town of Red Shirt, lying along the river on the northwest boundary of the Reservation, is the area the OST believes is most affected by the Angostura Unit. Social and economic conditions on the Cheyenne River or Lower Brule Reservations would not be affected, so they were not included in the analysis.

Methods

Regional Economic Analysis

Regional economic impacts were measured using the IMPLAN computer model, which translates changes in final demand for goods and services (such as agriculture and recreation expenditures) into resulting changes in the value of total output of the region, changes in employment, and changes in income. The coefficients used to represent purchases within the region were adjusted to reflect greater than average purchases of corn and hay from the local region, which translated into greater local impacts from any change in crop production.

Another important factor in the economic analysis was the effect of reduced water deliveries on crop production. If water were conserved by changing applications or by the timing of applications, crop yields might be maintained with less water. If water were not available, however, at critical times during the growing season—or if even minor volumes of water were unavailable—then reduction in crop yields might be significantly greater than the reduction in water deliveries.

A final consideration was the change in cropping patterns occurring from uncertain water deliveries. A change in availability of water to the District could result in significant changes in crops and economic activity. Local producers said that delivery of 75% of full irrigation would lead many to switch to dryland small grains, milo, and sudan grass forage (Jerry Watt, 1998: personal communication). Small grains might be economically viable on the better lands, although pasture would be the most likely viable dryland crop in the region after several years of establishment.

Local producers indicated that drought in the short term would result in reduced cultivated acreage roughly proportional to reduced water availability. This would be caused by reducing irrigated acreage to allow near full water deliveries to the remaining acres. It would be very difficult to replace irrigated crops on short notice because of the timing of planting, length of the growing season, and timing of harvest.

Over time, acreages that could not be irrigated would probably be taken out of production and put into pasture or possibly small grains. This would result in reduced agricultural activity, reduced agricultural income, and reduced spending in agricultural input sectors. Regional economic impacts of reduced irrigated acreage therefore were based on value of crop production and cost of production inputs per acre of irrigated land, minus crop value and input costs per acre of dryland, multiplying the difference by the reduced irrigated acreage.

Recreation Analysis

A computer model based on reservoir elevations and reservoir visitation was developed to estimate recreation impacts. Monthly reservoir elevations were obtained from Reclamation records, and annual visitation information for 1970-1996 was provided by SDGF&P's Division of Parks and Recreation. Economic data on changes in per capita income were collected for April-September, assumed to be the recreational season in the area. Average seasonal precipitation was included in the regression equation to account for the effects of weather on camping visitation.

The regression equation used in the analysis was represented as change in camping visits = f (change in the seasonal average reservoir elevation, change in seasonal precipitation, and a change in per capita income). Many other variables were considered, but data were either lacking or insufficient to explain changes in camping visitation. Independent variables (reservoir elevation, precipitation, and per capita income) were found to be significant based on the *t* and *F* statistics, and the expected signs for the variables were correct. The adjusted *R-square* is a statistical measure indicating how well the independent variables explain changes to the dependent variable (camping visitation). The regression equation developed for this analysis has a low adjusted R-square (.35), but this is probably due to the absence of other independent variables which influence camping visitation. Still, it was found that changes in reservoir elevations were statistically significant and would play a role in camping visitation at the reservoir.

Once the regression model was developed, seasonal average reservoir elevations for each alternative were obtained from AGRAOP. Using these data—and assuming other independent variables constant in the model—changes in camping visitation for each alternative were estimated. It was recognized that much recreation at the reservoir comes from day-use. Past visitation data showed that, on average, there were 10 day-use visits to each camping visit. This ratio was multiplied by the change in camping visitation to estimate change in day-use visitation.

Changes in reservoir elevations affect recreation facilities. Table 3.29 shows target elevations established in the alternatives and the

recreational purpose they would serve. The model didn't take into account qualitative impacts to boat ramps or other aspects such as beaches or the shoreline. Visitation is down when boat ramps are inaccessible because of low water,. On the other hand, when the reservoir is full, beaches are inundated and shoreline day-use may be reduced. Qualitative impacts to facilities and beaches can be assessed, however, by comparing when boat ramps would be inaccessible at various reservoir elevations. The table was developed using the same parameters as for the AGRAOP model based on the average of 10,000 irrigated acres.

County Population Characteristics

The 1995 population of the area was 13,764 (Table 3.30). Approximately 52% of this population resided in Fall River County, the rest in Custer County. Custer County's population grew at an annual average rate of 2.7% from 1970-1980 but slowed to less than 1% from

Table 3.29: Recreation Elevations in the Reservoir
(Assuming 10,000 irrigated ac.)

Elevation (ft.)	Recreational Benefit	% of 1953-1997 Period Elevations Achieved
3187.2	Target elevation December-May—most favorable for fish	11 months or 4.1%
3186	Target elevation in June—most favorable for fish and for beach formation	23 months or 51.1%
3185	Target elevation in July—most favorable for fish and for beach formation	12 months or 26.7%
3184	Target elevation in August-November —most favorable for fish and for beach formation	31 months or 17.2%
3175	All eight boat ramps at reservoir usable for April-September	220 months or 81.5%
3173	Elevation at which water conservation measures would be taken in Reservoir Recreation and Fisheries Alternative to preserve recreational benefits for April-September	238 months or 88.2%
3172	Four boat ramps usable for April-September	244 months or 90.4%
3170	Two boat ramps usable for April-September	252 months or 93.3%
3163	Top of inactive pool—no boat ramps usable	270 months or 100%

1980-1995. Fall River County's population grew from 1970-1980 by an annual average rate of 1.2% but experienced a decline from 1980-1995 by an annual average of about 1.0%. Population projections from the State Data Center at the University of South Dakota estimate the Fall River County population to continue to decline between 1995-2015, perhaps due to a further decline in agriculture and lack of industry in the county. For Custer County, population is projected to increase between 1995-2010 but at a slower rate than in the past. The largest town in Fall River County is Hot Springs with 4,098 people, which comprised more than 50% of the county's 1995 population (U.S. Department of Commerce 1990; 1997). In Custer County, the largest town is Custer with 1,807 people, comprising 27% of the county's 1995 population. Population trends for the towns follow patterns described for total county populations. Custer County's population increased in most towns between 1990-1995, while the towns in Fall River County declined during the same period. By way of comparison, Rapid City, the major regional center about 50 miles north of the reservoir, increased by about 6% during the same period.

About 97% of the population was white in both the 1980 and 1990 Censuses in Custer County (U.S. Department of Commerce 1990). Native Americans made up about 2.7% of the population in 1980 and 2.5% in 1990, with other races making up the rest. Hispanics (which include other races according to Census definition) make up less than 1% of the total population. In Fall River County in 1980 and 1990, the racial make-up was similar to Custer County: 93-94% white, followed by 5-6% Native American, with about 1% other races. Hispanics made up about 1.5% of the population during this period.

Table 3.30: Current/Projected County Population

	Fall River County	Custer County
1970	7,505	4,698
1980	8,439	6,000
1990	7,353	6,179
1995	7,089	6,675
2000	6,673	7,112
2005	6,563	7,677
2010	6,447	8,005

Sources: U.S. Department of Commerce 1990; 1997
South Dakota State Data Center 1997.

Table 3.31 shows civilian labor force in the two counties and unemployment rates for 1980, 1990, and 1994. The labor force increased by more than 40% in Custer County from 1980-1990, while unemployment fell by almost 50%. For Fall River County, the labor force declined by 6.1%, while unemployment declined by about 16%. The labor force decline was probably due to population loss in the county. The decline in unemployment could also have been due to the population loss, which included loss of unemployed people. In Custer County, the labor force did not significantly change from 1990-1994, but the unemployment rate increased by more than 50% during the period. This could be explained by the drop in employment in the agriculture and manufacturing sectors of the economy (see below). For Fall River, the labor force increased by about 6%, while unemployment fell by about 12%.

Table 3.31: County Civilian Labor Force and Unemployment Rate

	Civilian Labor Force	Unemployment Rate
Fall River County		
1980	3,475	5.10%
1990	3,264	4.30%
1994	3,461	3.80%
Custer County		
1980	2,441	5.30%
1990	3,506	2.70%
1994	3,507	4.30%

The number of households increased between 1970-1985 by more than 50% in Custer County (U.S. Department of Commerce, 1990; 1997). Between 1985-1990, households declined about 6%, probably due to the decline in population from 1985-1990. Persons per household declined between 1970-1990 by about 12%, similar to declines in the state and the nation. For Fall River County, households increased by 29% between 1970-1980, but the number of households declined by 5.3% between 1980-1990. This trend is similar to national population changes.

For both counties, the percentage of population 25 years and older who were high school or college graduates increased between 1980-1990 (U.S. Department of Commerce 1990). In 1990, 80.4% of the total population 25 and older in Custer County (4,138 people) graduated from high school, and 17.5% graduated from college. For Fall River County, 74.1% graduated from high school and 16.3% from college.

The percentage of the population below the poverty level declined in both counties between 1980-1990 (U.S. Department of Commerce 1990). For Custer County, the percentage declined by 13% between 1980-1990. For Fall River County, the percentage declined by about 30% during the same period.

County Economy

Income and Earnings

Table 3.32 shows personal income and total earnings (wages and salary, other labor income, and proprietors' income) for Fall River and Custer counties for 1985, 1990, and 1995. Total personal income in 1995 in Fall River County was $129.1 million (U.S. Department of Commerce 1969-1995). It increased by 7% between 1985-1990 and increased by 22% between 1990-1995. Per-capita income (income per person) in Fall River County in 1995 was $18,130, about 93% of the State average and 78% of the national average. Total personal income in 1995 in Custer County was $120.4 million. Personal income increased by about 26% between 1985-1990, and by about 23% between 1990-1995. Per-capita income was $17,850 in 1995 in Custer County, which was 91.4% of the State average and about 77% of the national average.

In Fall River County, total earnings in 1995 were $79.4 million (U.S. Department of Commerce 1969-1995). Between 1980-1990 earnings declined about 5% but increased by 22% between 1990-1995. Total earnings for Custer County in 1995 were $56.9 million. Earnings increased 33% between 1985-1990, by 23% between 1990-1995.

Table 3.32 also shows earnings by industry over the same time periods. In Fall River County, the larger industries based on earnings in 1995 were government; services; and transportation, utilities, and communications (U.S. Department of Commerce 1969-1995). In 1985, the largest industries had been government, services, and agriculture. Changes in earnings over the period show agriculture consistently declining. Between 1985-1990, agricultural services,

Table 3.32: Personal Income and Earnings by Industry (millions)

	Fall River County			Custer County		
	1985	1990	1995	1985	1990	1995
Total Personal Income	$94.18	$100.91	$129.07	$71.70	$90.08	$120.39
Total Earnings	$68.23	$64.88	$79.41	$34.68	$46.21	$56.92
Earnings by Industry						
Farm	$12.00	$5.47	$1.48	$0.53	$1.23	($0.82)
Ag. Services/ Forestry/Fish/ Other	$0.30	$0.49	[1]	$0.43	$0.22	[1]
Mining	$2.42	$0.75	[1]	[1]	$0.58	[1]
Const.	$2.01	$1.35	$2.18	$1.60	$3.03	$4.41
Manu.	$0.59	$0.54	$2.28	$3.25	$4.71	$1.25
Trans./Util./ Comm.	$14.25	$13.75	$15.11	$2.27	$2.62	$5.14
Trade	$7.13	$6.89	$9.68	$5.25	$6.43	$8.37
Finan./Insur/ Real Estate	$0.86	$1.07	$1.51	$0.53	$0.79	$1.51
Services	$6.19	$7.60	$11.51	$7.72	$9.15	$14.85
Government	$22.49	$26.96	$34.12	$11.29	$17.36	$21.61

[1] Information on earnings of this industry unavailable due to concerns about confidentiality; earnings included in total earnings for the year, however.
Source: U.S. Department of Commerce 1969-1995.

Table 3.33: Total Number of Businesses, Total Employment and Employment by Industry

	Fall River County			Custer County		
	1985	1990	1995	1985	1990	1995
Total Number of Businesses	190	180	198	167	184	225
Total Employment	3,761	3,736	3,967	3,118	3,526	3,755
Employment by Industry						
Farm	468	412	362	363	341	323
Ag. Services/ Forestry/Fish/ Other	39	56	[1]	37	52	[1]
Mining	83	55	[1]	[1]	65	[1]
Const.	137	118	145	[1]	182	243
Manu.	66	55	139	251	281	152
Trans./Util./ Comm.	369	321	310	96	120	153
Whsle. Trade	27	30	17	29	31	32
Retail Trade	602	626	713	501	601	698
Finan./Insur/ Real Estate	125	96	111	137	154	156
Services	646	786	875	750	790	954
Government	1,199	1,181	1,173	726	909	917

[1] Information on employment in this industry unavailable due to concerns about confidentiality; employment included in total employment for the year.
Sources: U.S. Department of Commerce 1969-1995; 1985-1995.

services, and government sectors increased in earnings, while the remaining sectors declined. By 1995, earnings were greater than in 1990 for most of the industries in this county, with the exception of agriculture.

In 1995, the largest industrial sectors in Custer County were government ,services, and trade, the same as they had been in 1985. Changes in earnings during the period show the agriculture sector peaking in 1990 and falling in 1995; this is true for manufacturing, also. Transportation, utilities, and communications; construction; finance, insurance, and real estate; trade; services; and government sectors showed significant growth in earnings between 1980-1995.

Business Establishments and Employment

The total number of businesses, total employment, and employment by sector for both counties are shown in Table 3.33 for 1985, 1990, and 1995. In Fall River County, there were 198 business establishments with total employment of 3,967 full and part-time jobs in 1995. Between 1985-1995, business establishments decreased by 5.3%, total employment by about 1%. Between 1990-1995, business establishments increased by 10%, total employment increased by 6.2%. There were 225 business establishments in Custer County in 1995, and total employment was 3,755 full and part-time jobs. The increase between 1985-1995 in business establishments was 10.2 %, and in total employment 13.1%. Between 1990-1995, the increase in business establishments was 22%, total employment by 6.5%.

In Fall River County, the largest employers in 1995 were government (30%), services (22%), and trade (18%). Agriculture was the fourth largest employer in this county. The employment trend shows agriculture; transportation, utilities, and communication; and the government sectors declined in the past ten years, while services and manufacturing increased.

In 1995, the largest employers based on total employment in Custer County were services (25%), government (24%), trade (19%). Agriculture was the fourth largest employer in this county also, with 8.6% of total employment. Past employment trends show agriculture declining since 1985, and manufacturing declining between 1990-1995. Other industrial sectors grew, particularly transportation, utilities, trade, services, and government.

Irrigated Agriculture

Table 3.34 shows the number of farms, irrigated acreage, and market value of crops sold for the two counties based on the U.S. department of Commerce's *Census of Agriculture* (1992). Information was also obtained from Reclamation's annual summary reports and *Angostura Irrigation District Payment Capacity Study* (U.S. Bureau of Reclamation 1995). Total number of farms have increased in Custer County but have decreased in Fall River during 1982-1992. Irrigated acreage has declined for both counties, perhaps due in some part to the Conservation Reserve Program allowing farmers to set aside acres for conservation.

Most irrigation in Fall River and Custer counties is in the District. The District irrigates about 10,000 acres on average, with principal crops being alfalfa and corn. These provide a feed source for the livestock raised in the area. Each year an average of 28,000 AF of water from the reservoir is delivered to District lands, providing about 70% of the CIR on average. Without irrigation, crop production would be reduced to nothing some years, which would severely affect livestock production in the area.

Several factors were considered when evaluating regional economic impacts of

Table 3.34: Number of Farms, Irrigated Acres, Value of Crops and Other Information

	Fall River County			Custer County		
	1982	**1987**	**1992**	**1982**	**1987**	**1992**
Total Number of Farms	336	339	298	302	303	323
Irrigated Acres	14,729	13,085	12,154	5,418	5,187	3,167
Market Value of Crops Sold (thousands)	$431	$715	$759	$2,621	$1,849	$2,835
Average in District						
	1983	**1990**	**1993**	**1994**	**1990-1994**	
Total Irrigated Acres	12,218	12,218	12,218	12,218	12,218	
Harvested Cropland Acres	8,868	8,376	10,114	10,594	9,645	
Cropland Not Harvested and Soil Building Acres	2,576	1,717	120	91	423	
Dry-Cropped, Fallow or Idle Acres	476	1,827	1,686	1,228	1,850	
Farmsteads, Roads, Ditches, and Drains Acres	298	298	298	305	299	
Gross Crop Value (millions)	$2.23	$1.50	$1.81	not available	not available	
Number of Farms	70	78	70	not available	not available	

Sources: U.S. Department of Commerce 1992; U.S. Bureau of Reclamation 1995.

changes in irrigation deliveries to the District. One was location of a feedlot in the District which depends heavily on irrigated corn and hay production from the District. The feedlot, with a 25,000-head capacity, requires 10,000-11,000 bushels of corn/day and about 16,000 tons of hay/year. The District supplies about 25-30% of the corn and hay, representing about 900,000 bushels of corn and 4,000 tons of hay annually. The feedlot therefore represents the primary source of demand for District crops and is thus critical to the local economy. The feedlot has about 1,000 acres of farmland, 70% irrigated. It directly employs 25 people and indirectly employs many more through its demand for local inputs. Gross sales from the feedlot—most of which comes from custom feeding—average a little more than $11 million annually and net sales revenues are about $2 million annually. The market value of agricultural products sold increased during 1982-1992. In Fall River County, which has a feedlot, livestock and poultry sales made up 96% of total sales. The feedlot is dependent on alfalfa hay and corn grown in the District. Livestock and poultry products made up 90% of total sales in Custer County.

Gross crop value had declined in the district from 1983-1993, but harvested cropland has increased. This may be due to falling market prices for crops grown in the District.

A regional impact analysis done for the *Angostura Reservoir Resource Appraisal Report* (U.S. Bureau of Reclamation, 1996) estimated net impacts from irrigated agriculture in the District to the regional economy. (Net impacts are those under current irrigated conditions minus likely impacts with dryland crops). Farm production costs and income from the payment capacity study were used to estimate regional impacts.

The appraisal report did not fully account for regional impacts from the location of a large feedlot in the Angostura area. Changing the analysis to account for the feedlot resulted in estimated regional impacts of $2.32 million in total regional output, $540,000 in employee income, and 47 jobs annually. The benefits of irrigation to the nation were estimated to be $520,000 annually (U.S. Bureau of Reclamation 1996).

Recreation

Recreational opportunities at Angostura Reservoir add to the regional economy. Table 3.35 shows annual recreation visitation and fees received between 1970-1996 (South Dakota Game Fish and Parks 1997). Lack of access below the dam discourages recreational use of the river, although there are some limited shoreline fishing, canoeing, and camping. Use is so minimal that it was not considered a factor in the recreational analysis.

Facilities—Recreation at Angostura is managed by SDGF&P under an agreement with Reclamation. About 1,500 acres on the east shore (see fig. 2.1) of the reservoir have been classified a State Recreation Area, with campgrounds, boat ramps, marina, cabin area, day-use areas, and swimming beaches. The remaining 3,150 acres along the west and south shores are managed mainly for wildlife, although there are some boat docks and restrooms.

Visitation—On average, recreation visits increased over the 26-year period. Some declines occurred during droughts when water levels were low, most notably in 1976-1977 and again in 1988-1989. Recreation revenue increased most of the years between 1986-1996. In 1996, total recreational fees collected at Angostura Recreation Area were about $215,000.

Expenditures by non-local recreationists visiting the reservoir also contribute to the regional economy. Visitation in 1994 was divided by recreational activity, which was then matched to expenditures by recreation activity provided by the 1991 *National Survey of Fishing, Hunting, and Wildlife-Associated Recreation* (U.S. FISH and Wildlife Service 1992). The percentage of recreation by activity was obtained by using 1980 recreational use data collected at the reservoir (U.S. Bureau of Reclamation 1981).

Table 3.35: Recreation at the Reservoir, 1970-1996

Year	Day Use (visitor-days)	Camping (visitor-days)	Total Visits (visitor-days)	Annual Increase in Visits (%)	Revenue from Recreation Fees
1970	90,136	7,260	97,396		[1]
1971	92,526	14,484	107,010	9.87	[1]
1972	91,101	18,932	110,033	2.82	[1]
1973	100,005	23,924	123,929	12.63	[1]
1974	105,700	25,120	130,820	5.56	[1]
1975	192,860	18,847	211,707	61.83	[1]
1976	216,156	20,712	236,868	11.88	[1]
1977	207,275	17,270	224,545	-5.20	[1]
1978	205,429	21,961	227,390	1.27	[1]
1979	266,769	26,240	293,009	28.86	[1]
1980	247,969	25,271	273,240	-6.75	[1]
1981	245,216	24,045	269,261	-1.46	[1]
1982	243,447	23,168	266,615	-0.98	[1]
1983	233,438	22,541	255,979	-3.99	[1]
1984	241,875	21,360	263,235	2.83	[1]
1985	245,567	18,523	264,090	0.32	[1]
1986	223,937	18,469	242,406	-8.21	$73,843
1987	214,813	20,950	235,763	-2.74	$80,699
1988	222,548	17,129	239,677	1.66	$77,224
1989	190,701	11,744	202,445	-15.53	$59,296
1990	206,155	14,808	220,963	9.15	$81,475
1991	241,759	19,148	260,907	18.08	$113,099
1992	269,970	21,981	291,951	11.90	$141,167
1993	184,870	26,699	211,569	-27.53	$155,369
1994	240,767	30,316	271,083	28.13	$202,061
1995	230,723	32,956	263,679	-2.73	$204,407
1996	260,038	30,731	290,769	10.27	$214,497

[1] Revenue information available for 1986-1996 only.

Source: South Dakota Game, Fish and Parks 1997.

These data are believed to be reasonably accurate and is the best available for estimating current recreation use patterns. The percentages were used for activities other than camping (SDGF&P's Division of Parks and Recreation had already broken out that activity) to estimate 1994 visitation by recreational activity. Once this was done, the 1991 survey expenditure/visit by activity was multiplied by estimated 1994 visits by activity to develop a total expenditure per activity. Expenditures were adjusted to account for only dollars spent by recreationists who reside outside the Angostura area. From this data, regional impacts were developed using techniques similar to those used to estimate irrigation impacts discussed above.

Recreational activities at the reservoir include boating, camping, fishing, hunting, picnicking, day use, swimming, bicycling, hiking, and bird watching. Since the early 1970s, Angostura has experienced steady visitation growth (Table 3.35), reaching a record high of 293,000 in 1979 (South Dakota Game Fish and Parks 1992).

Regional impacts from recreational activities in 1994 were estimated to be $3.41 million in total regional output, $1.20 million in employee income, and 92 jobs annually. Recreational benefits from the reservoir to the nation were estimated to be approximately $7.1 million annually based on a travel cost model developed for the appraisal study (U.S. Bureau of Reclamation 1996).

Population Characteristics of the Pine Ridge Reservation

Total land area of the Pine Ridge Reservation is about 1.8 million acres, covering all of Shannon County and about two-thirds of Jackson County. Before the 1980 Census, the Reservation contained part of Washabaugh County, but this has since been combined into Jackson County. Part of the Badlands National Park is also within the Reservation and Buffalo Gap National Grasslands lies just to the west.

Population estimates from the Census are shown in Table 3.36 for 1970, 1980, and 1990, along with the projected 2010 Reservation population. The 2010 estimate is based on the 1988 University of South Dakota Business Research Bureau projections for Shannon County and 55.5% of Jackson County's projected growth. The 2010 population projection can be compared to the Census estimates to get an idea of the growth expected on the Reservation.

Census data showed an overall decrease in Reservation population from 1970-1990, although there was a significant increase from 1970-1980. The population grew at a rate of 2.5% annually from 1970-1980, which was higher than the 1% average growth rate for the State. From 1980-1990, however, the population decreased at an average rate of 3.8% per year. The 2010 projection indicates growth is again expected over the next decade.

Table 3.36: Reservation Population

Year	Total	By County			
		Shannon	Washabaugh	Jackson	Bennett
1970	12,675	8,198	1,389		3,088
1980	16,273	11,323		1,906	3,044
1990	11,179	8,724		1,078	1,377
2010	19,113				

Sources: U.S. Department of Commerce 1990; 1997.
South Dakota State Data Center 1997.

The estimates in Table 3.36 are mainly based on Census data. It is generally recognized, however, that Census estimates in rural areas, including many Indian reservations, can significantly underestimate the true population. Underestimation can result from missing households or inaccuracies in counting the number of people living in each home. The number of people/household reported by the Census on reservations are frequently lower than estimates provided by other agencies and by tribes. As a result, the estimates probably underestimate the actual past population of the Reservation.

Population estimates provided by BIA (U.S. Bureau of Indian Affairs) represent all Native Americans on the Reservation (1996). BIA estimates usually provide a more accurate estimate of Reservation population because they correspond more closely with Tribal enrollment figures and more correctly measure the number of Native Americans using services on the Reservation. BIA estimated the service area population at 20,806 in 1991 and 38,246 in 1995. The 1995 estimate is probably the most representative of the Reservation population.

The Census estimated that there were 2,571 households on the Reservation in 1990 and there was an average of 4.4 people/household (U.S. Department of Commerce 1990). Of the total housing, about 46% were owner-occupied; the median value of owner-occupied housing was about $15,000. About 1,400 units were under some type of rental contract. About 23% of all housing lacked plumbing, while 90% had water service from public or private systems or from a well.

In1990, 4,932 people on the Reservation were enrolled in school. High school graduates and those with higher education made up 58.5% of the population (9% with a bachelor's or higher college degree). About 92% of the Reservation population is Native American, with the rest either white or Hispanic.

Economy of the Reservation

The 1990 Census estimated per-capita income on the Reservation to be $3,520, compared to $10,661 for South Dakota and $14,420 for the nation (U.S. Department of Commerce 1990). The same pattern of low income is reflected through 1990 Census estimates of median household income, estimated to be $11,255, compared to $22,503 for the state and $30,056 for the U.S. The 1990 Census estimated unemployment to be 29.4% on the Reservation, compared to 4.2% in the state and 6.3% in the U.S.

If 1990 Census data is divided into Indian and non-Indian populations, per-capita income of the Indian population on the Reservation is about $3,350 and unemployment about 32.6%. In addition, a little over 44% of the Indian population did not have a high school degree or the equivalent in 1990, compared to about 23% for the state and 24.8% for the U.S.

Census estimates probably underestimate the true unemployment on the Reservation because of how unemployment is defined. Once people stop seeking employment, they are no longer considered to be in the labor force and are thus not counted as unemployed. Slightly more than 50% of the Indian population 16 years and older on the Reservation was not considered to be part of the labor force in the 1990 Census. This is a large percentage (about 33.8% of those 16 years old and older in South Dakota are not part of the labor force), and a significant part of this 50% on the Reservation not considered part of the labor force are chronically unemployed and have given up finding work. This fact—combined with potential under-employment problems where those who have part-time jobs would like full-time jobs—results in

unemployment much higher than the 1990 Census figures indicate.

According to BIA data, the total 1995 labor force on the Reservation numbered 9,130, 4,965 of whom were employed (U.S. Bureau of Indian Affairs 1996). The unemployment rate was about 54%, in comparison to 4.3% for Custer County and 3.8% for Fall River County. About 52% of the labor force (4,800 people) earned $9,048 or more per year. About 63% of the Reservation population was below the poverty level, in comparison to 11.85% of the Custer County population, 12.84% of the Fall River population.

A number of service and retail businesses can be found on the Reservation, and Federal programs provide some jobs as well as services. The Oglala Lakota College also provides employment. Other business operations—such as Cedar Pass Lodge in Badlands National Park, bingo operations, and the Prairie Wind Casino 12 miles west of Ogallala—are owned and operated by the OST, contributing to the Reservation economy.

There could be economic connections between the District and the Reservation, such as in jobs and earnings of OST members associated with irrigated agriculture in the District and with the feedlot. While this analysis was unable to quantify these jobs, earnings, or other economic connections, it is still recognized that there might be some and that these economic connections could be affected by the alternatives.

Red Shirt

Information was provided by the town manager on population, demographic data, employment, schooling, and housing in Red Shirt. The 1998 population was 240 people, having increased only slightly over the past 10 years (Chris Eaglehawk, 1998: personal communication). Employment in the town comes mostly from agriculture (ranching), government agencies (Tribal, State, and Federal), and the Tribal casino. Limited employment is also provided by the local cottage industry producing traditional Native American crafts and art.

Housing in the town consists of 40 units, 22 of which are owner-occupied, the rest rental units. Most are multi-dwelling units. The Shannon County Elementary School in Red Shirt educates kindergartners to 8th graders, while high school students are bused to nearby county schools.

Social and economic conditions on the Reservation are worse in comparison to conditions in Fall River or Custer counties. The Reservation has a high level of unemployment, greater infant mortality, percentage of people living below the poverty level, and less owner-occupied housing when compared to South Dakota or the nation as a whole, based on the 1990 Census and 1995 Census update.

INDIAN TRUST ASSETS

ITAs (*Indian Trust Assets*) are properties, interests, or assets of an Indian tribe or individual Indian over whom the Federal government also has an interest through administration or direct control. Examples include lands, minerals, and timber, as well as water rights, hunting rights, fishing rights, and other treaty rights. The sovereignty of tribes and the trust relationship with the Federal government have been established and validated through treaties, court decisions, legislation, regulations, and policies. Reclamation's policy on ITAs is that impacts must be determined and considered when implementing Reclamation actions.

One of the objectives of consultations with the OST, CRST, and LBST, and public meetings on the reservations was to identify concerns the tribes might have with ITAs (see Chapter 5).

Meetings determined three ITA concerns: Water rights, culturally important plants, and fisheries.

Water Rights

As explained in Chapter One "Water Rights," Indian water rights are based on the Winters Doctrine. This doctrine states that enough water was reserved (set aside) when Indian reservations were established to fulfill purposes for which the reservations were originally created. The priority date for reserved water rights are the date on which the particular reservation was established.

Both the OST and the CRST probably have claims to the water of the Cheyenne River under the Winters Doctrine. The Pine Ridge Reservation and the Cheyenne River Reservation were established by the Act of 1889, which means claims of the OST and CRST would have priority over claims of most other appropriators in the basin.

The fact that neither Tribe has exercised their rights does not negate their reserved water rights under the Winters Doctrine to water in the river. If the Tribes eventually exercise their reserved rights and put the water to beneficial use, the volume of water available for other users in the basin might be affected.

Culturally Important Plants

The OST voiced concerns about possible changes in the local abundance and distribution of plants traditionally used by the Tribe. Many believe changes in traditional plants can be linked to the Angostura Unit. The plants are American plum, silver buffaloberry, and common chokecherry. These plants are shrubs-to-small-trees, ranging throughout central and eastern North America. Locally, American plum generally forms small thickets along drainageways or in sheltered prairie depressions (Johnson and Nichols 1982). Common chokecherry forms thickets along fence rows or valley bottoms, and occurs as scattered understory in open woods. Both chokecherry and American plum are considered quite drought resistant. Silver buffaloberry is scattered, frequently occurring along streams, on moist hillsides, and in bottom lands. The small fruit from these three species has value to both people and wildlife.

Traditionally, the Lakota used these plants for food and medicines (Gilmore 1977; Hassrick 1964; Kindscher 1996). Both Gilmore and Kindscher reported that the Lakota used the sprouts of wild plum in making *wau^{n}ya^{n}pi*, an offering or form of a prayer, especially for the benefit of the sick. Wild plum was also used for food (Hassrick 1964). Further, August is referred to as "Moon of the Ripe Plums" (Hassrick 1964).

Buffaloberry was used for food and dried for use during the winter (Gilmore 1977). It was also used ceremonially in feasts and had some minor medicinal uses (Kindscher 1996).

Chokecherry was probably the most important of the three plants to the Lakota economy (Gilmore 1977; Kindscher 1996). It was especially valued as food, a favorite being as the major fruit in *wasna*, a form of pemican (Gilmore 1977; Kindscher 1996).
It was occasionally used for arrow shafts (Hassrick 1964), to make mush, and for tea (Kindscher 1996). It also had medicinal uses such as for the treatment of minor stomach ailments and as a poultice to stop bleeding (Kindscher 1996).

Chokecherries were also used in female puberty ceremonies and the White Buffalo Ceremony (Hassrick 1964). The time of the Sun Dance was determined by the ripening of the cherries and, in this respect, the month of July is referred

to as "Moon of Ripening Chokecherries" (Gilmore 1977; Hassrick 1964).

Authorities and scientific literature indicate reported declines in local abundance and distribution of the three plant species probably are not linked to changes in the river from construction of Angostura Dam. Only common chokecherry was found on a list of plants compiled by USFWS as occurring in wetlands (1988). The list defines chokecherry as a plant that usually occurs in non-wetlands (67-99% of the time), but occasionally can be found in wetlands (1-33% of the time). *Prunus* species (plum and chokecherry) require well drained soil, a condition more common in upland sites. Buffaloberry is more likely found associated with green ash communities on drier upland sites, rather than with cottonwood/willow communities in riparian sites. Thus, while these plants may occur near streams, they are correctly characterized as upland species.

Perceived declines in abundance or distribution of plum, chokecherry, and buffaloberry are likely due to land-use changes. All three have only limited value as forage, although livestock may eat the leaves and twigs of the plants when more palatable forage is limited. Buffaloberry is sensitive to grazing, and plum and chokecherry may also decline if grazing pressure is severe. Chokecherry, however, may be toxic to livestock if consumed in large quantities (Johnson and Nichols 1982).

Livestock congregating near streams or other water sources may also affect plant communities by trampling or by compacting the soil. Grazing data were not available for analysis, but livestock use of the stream corridor of the river may have contributed to perceived declines in the local abundance and distribution.

Fire is another factor that may affect abundance and distribution of the three plants. In prairie grasslands, fire tends to suppress or eliminate woody plants. Most *Prunus* species are generally fire resistant, although burning during the growing season and frequent fires may adversely affect chokecherry. Fire suppression policy may favor increased abundance of these species. As with grazing, fire management data were not available, but it is likely that fire has played a role in local abundance and distribution of these plants.

It appears unlikely that reported declines in local abundance and distribution of American plum, common chokecherry, and buffaloberry on the Reservation are linked to the Angostura Unit. These three plants are generally considered upland species and thus occur beyond the influence of the dam. Decline in abundance and distribution is likely related to land management practices on the Reservation, such as grazing and fire.

Fisheries

Because the Ft. Laramie Treaty of 1851 recognized the right of the Lakota to continue to fish in ceded lands, fishing thus meets the definition of an ITA. Article 5 of the treaty recognized that fishing was an economic activity to which they were entitled to continue to pursue:

> It is, however, understood that, in making this recognition and acknowledgment, the aforesaid Indian nations do not hereby abandon or prejudice any rights or claims they may have to other lands; and further, that they do not surrender the privilege of hunting, fishing, or passing over any of the tracts of country heretofore described.

The historic Lakota economy revolved around buffalo hunting, and discussions about the subsistence economy have focused on buffalo, as well as antelope and deer (Howard 1980;

Hassrick 1964). Only minimal attention has been given to fish in the Lakota's subsistence (Howard 1980; Rustlund 1952). Rustlund (1952), in his overview of fishing among the tribes, did not associate any specific fishing technology to the Lakota. Howard (1980) associated fishing more with the Santee and Middle Dakota than the Lakota Sioux; the latter considered fish "unclean". Both the Santee, Yankton, and Yanktonai Dakota Tribes made use of weirs to catch fish. Archaeological evidence (including both a weir and fish bone) from the Dirt Lodge Site (39SP11), a historic Santee Sioux site on the James River in Spinks County, South Dakota, supports this view (Haberman 1983).

Hassrick (1964) contradicted somewhat Howard's downplaying of fish in Lakota subsistence. Fishing was done with a hook, spear, or a rawhide blanket in which holes were punched to serve as a net. Suckers were among the fish used historically. Hassrick (1964) cited an informant who reminisced about catching suckers with a spear or pole and noose. Hassrick (1964) included a drawing of a fish spear and a rawhide blanket net.

The CRST conducted an ethnographic analysis of the importance of fishing to Tribal members for this EIS (see Appendix Y). Walker documented 38 species (both native and introduced) are culturally significant. Most are used for food, especially among economically disadvantaged Tribal members. Walker also stated that fish have religious significance; they are the focus of the "Feast of the Raw Fish," a major ceremony.

Further evidence of fish in Lakota subsistence comes from cognates for the word "fish." Table 3.37 shows Lakota cognates for fish, specific fish species, and activities associated with fishing. The Lakota have words for several species of fish present in the Cheyenne River or nearby drainages (Everman and Cox 1896). That the Lakota distinguished these different species and had distinct cognates for different fishing activities indicate that fishing did play a role in their subsistence economy.

Table 3.37: Lakota Words Associated with Fish

Fish and Fish Species	
English	**Lakota**
fish	*Hogaŋ*
carp	*Hoiwotka, hosaŋ*
catfish	*Howasapa*
eel	*Hoka, zuzuecahongaŋ*
grass pike	*Hogleglega*
rainbow	*Hogleglega*
red-fin	*Hoapes´a*
shad	*Holaska*
Fishing Activities	
fish hook	*Cakiyuh ʼlate, hoicuwa, hoipate, hoiupsiu*
to fish	*Hokuwa*
to collect fish	*Homnayŋ*
to spear fish	*Hopataŋ*

Source: Buechel 1983.

As noted in the "Fisheries" section in this chapter, the Cheyenne River below the dam to the confluence with the Belle Fourche River is typical of western streams after regulation. Water is colder there than downstream and less turbid. Fish species requiring turbid water are found less frequently or not at all, having been replaced by fish species preferring clear, less turbid water. The fish health analysis found measurable concentrations of seven insecticides and one herbicide in fish in the river. Six of the insecticides are now banned, so the concentrations are assumed to be residue from

past use. The other insecticide is not known to be in use in the District. The herbicide, by contrast, is in use in the District, but concentrations in fish above the District are greater than those downstream. Concentrations of heavy metals were well below EPA's Fish Advisory Screening Values.

ENVIRONMENTAL JUSTICE

Executive Order 12868 signed February 11, 1994, requires Federal agencies to identify and address "Disproportionately high and adverse human health and environmental effects of its programs, policies, and activities on minority populations and low-income populations." Federal agencies must consider whether impacts of their activities place an undue burden on low-income or minority populations in regard to the environment or human health. No person or group should shoulder a disproportionate share of negative environmental or human health impacts associated with the implementation of a Federal program, policy, or activity.

Compliance under the executive order in regard to Native Americans is addressed in Section 6-606:

> Each Federal agency responsibility set forth under this order shall apply equally to Native American programs. In addition the Department of the Interior, in coordination with the Working Group, and, after consultation with tribal leaders, shall coordinate steps to be taken pursuant to this order that address Federally- recognized Indian Tribes.

Reclamation prepared this EIS in part because of a request from the OST Tribal Council. Scoping meetings have been held on the Pine Ridge, Cheyenne River, and Lower Brule Reservations, and the Re-Establishment of Natural Flows Below the Dam Alternative was developed to address Tribal concerns. Further, Reclamation contracted with the OST to provide information for this EIS. Impacts to the Tribes, including those to social and economic conditions and to Indian Trust Assets, are analyzed in the EIS.

It should be noted that the EIS considers impacts of contract renewal and water management on the current and future environment of the Cheyenne River basin and health conditions of low income or minority populations. It does not consider past impacts dating from construction of Angostura Dam.

As required by CEQ (Council of Environmental Quality) regulations, environmental justice has been evaluated according to three criteria: Whether impacts are significant or above generally accepted norms; whether contract renewal and water management pose a significant environmental hazard to a minority or low income group which appreciably exceeds the risk to the population in general; and whether impacts, when combined with effects of other projects, pose a cumulative environmental hazard to a minority or low income group.

CULTURAL RESOURCES

Cultural resources are archaeological, historical, or architectural sites, buildings, structures, objects, and districts, or properties of traditional religious and cultural importance to Native Americans, based on the definition in NHPA (National Historic Preservation Act). Section 106 of the act specifies that Reclamation, as the Federal agency responsible for the contract, must consider the impacts of the alternatives on historic properties. In addition, comments were received from the public on effects of the alternatives on cultural resources.

For purposes of this EIS, the Angostura area was defined as Reclamation-administered lands at Angostura Reservoir, the District, and the Cheyenne River downstream from the dam to the west boundary of the Cheyenne River Reservation. This last area was further delineated to the first terrace (T1) immediately next to the floodplain on both sides of the Cheyenne River. Impacts would be unlikely to extend beyond T1. The area encompasses two regions in the South Dakota State Plan for Archeological Resources (Winham and Hannus 1991): The South Fork Cheyenne River and the Central Cheyenne Archeological Regions. The South Fork Cheyenne region is probably better known than the Central Cheyenne region, because of investigations at Angostura Reservoir summarized in Reclamation's appraisal report (1996).

Investigations in the South Fork Cheyenne Archeological Region—especially those associated with the Smithsonian River Basin Survey for Angostura Reservoir—contributed greatly to knowledge of the region. In contrast, few investigations have been conducted in the Central Cheyenne Region, so knowledge of the region is necessarily less.

Cultural History of the Angostura Area

The cultural history of the area can be divided into four periods (Table 3.38). These periods are those generally employed when discussing archaeology of South Dakota and the northern Great Plains (Winham and Hannus 1991; Frison 1991). Each period is distinguished by specific artifact types and, in some instances, site types. Sites and objects representative of each of the periods have been found in the Angostura area.

Paleo-Indian occupations are identified by skillfully crafted projectile point types—Clovis, Folsom, Plainview, Goshen, Angostura, among others—and are best known from kill-sites containing remains of late Pleistocene fauna. Paleo-Indian artifacts have been found in and next to the area. The Ray Long Site (Winham and Hannus 1991) and two more Paleo-Indian sites are at the reservoir.

Evidence for the succeeding Archaic Period is more widespread than for the Paleo-Indian Period. The Archaic Period is distinguished by appearance of a unique set of projectile point types and stone tools.

Except for materials associated with the Early Archaic, evidence for Archaic Period occupation is fairly widespread in the region; 18 sites were found at the reservoir, (Haug et al. 1992). The Late Prehistoric Period is distinguished by a new set of projectile points and the appearance of ceramics. Twenty-four sites of this period can be found at the reservoir. Several suggest fairly intensive occupation over a long period of time. The most distinctive type associated with this period is the *earthlodge village*, which consists of the remains of permanently occupied settlements.

The final period, the Contact/Historic Period, begins with the appearance of Euroamerican trade items in Native American occupation sites. Historic accounts of explorers, traders, and missionaries indicate that a number of tribes either occupied or were present in the area early during this period, including the Lakota, Pawnee, Sioux, Apache, Kiowa-Apache, Kiowa, Cheyenne, Arapaho, Crow, and Ponca (Schlesier 1994). Historic Euroamerican sites include trading posts, cabins, military sites, farmsteads, churches, early reservation housing, and/or features associated with early irrigation. More recent historic structures include Angostura Dam and the facilities associated with the District.

Table 3.38: Prehistoric/Historic Periods Represented in the Angostura Area

Period	Duration	Description	Sites
Paleo-Indian	12,000-8,000/ 7,500 years bp (before present)	Nomadic hunter-gatherers who exploited Pleistocene fauna	Ray Long Site
Early Middle Late Archaic	8,000/ 7,500-2,000/ 1,500 years bp	Nomadic, generalized hunter-gatherers who exploited modern animals and plants. Used the atlatl	Includes occupation sites and lithic scatters
Late Prehistoric	2,000/ 1,500 years bp, circa 1750 AD	Increased sedentism, introduction of horticulture, ceramics, and bow and arrow.	Includes artifact scatters, rock-shelters, stone circles, and earthlodge villages
Contact and Historic	circa 1750 AD to Present	Advent of Euro-americans and Euro-american technology into the area	Trading posts, post-1850 farmsteads and early irrigation systems

South Fork Cheyenne Archeological Region

The South Fork Cheyenne Archaeological Region includes the upper end of the Cheyenne River basin. It is bounded on the west by the Black Hills and includes southeastern Meade County and parts of Pennington, Custer, and Fall River counties (Winham and Hannus, 1991). The first systematic surveys of the region were done by the SI-RBS (Smithsonian Institution-River Basin Survey) in conjunction with construction of Angostura Dam. Investigations at the reservoir can be divided into two periods: The first, defined by SI-RBS investigations, taking place in the late 1940s before construction (Bauxar 1947; Hughes 1949; Wheeler 1995; White and Hughes 1948). Beginning in the 1980s, the second period of investigations occurred, spurred primarily by Reclamation's operation, maintenance, and administration of the reservoir and nearby public lands (Haug et al. 1987; Haug et al.1992; Lippincott 1996; Hannus 1986; Hannus et al. 1993).

A total of 112 prehistoric and historic sites have been recorded on lands administered by Reclamation around the reservoir (see Appendix X). Of these, 100 are prehistoric sites, 4 are historic sites (buildings or structures), 5 have both prehistoric and historic components, and 3 are paleontological sites with possible evidence of prehistoric occupation. Occupation sites, lithic scatters, stone circle sites, rockshelters, and paleontological sites are the prehistoric sites present. Occupation sites are scatters of artifacts, bone, occasional pottery shards, and fire-cracked rock, assumed to be occupied over an extended time. Lithic scatters are distinct accumulations of stone (lithic) tools and/or debris from their manufacture. (Artifact densities at such sites are generally low.) This category includes the *workshop site* type mentioned in some literature (Haug et al. 1987). Stone circle sites—also called *tipi rings*—are distinguished by one or more circular stone alignments thought to have held down lodge flaps. Rockshelters are occupied rock overhangs. Paleontological sites contain only remains of Quaternary Period animals but are presumed to be the result of human activity. Historic sites consist almost exclusively of farmsteads and/or features associated with early irrigation systems. All are post-1850 in age and are associated with the appearance of Euroamericans in the area.

Following the 1987 investigations at the reservoir (Haug et al. 1992), Reclamation consulted with the South Dakota SHPO (State Historic Preservation Office) about NRHP (National Register of Historic Places) eligibility for these sites, as required by the National Historic Preservation Act (Appendix X). Sites 39FA75 and 39FA91—rockshelters with petroglyphs— are currently included in NRHP. There was agreement that another eight sites, including 39FA65, the *Ray Long Site*, also qualified as historic properties although they have not been formally nominated to NRHP. The potential of 7 other sites needs to be evaluated; existing data are insufficient for determination. Sixty-five sites do not qualify as historic properties, including some SI-RBS sites that could not be relocated during the 1987 investigations. These sites are presumed destroyed. Should any of them be relocated in the future, they will have to be evaluated.

Reclamation and SHPO also have agreed that Angostura Dam qualifies for inclusion in NRHP, considered eligible because of its exceptional importance to water delivery and development of irrigation in the region and the fact that it was the first dam completed under the Pick-Sloan Missouri River Basin Program. Determination for the NRHP has not been completed.

The District is also within the South Fork Cheyenne Archaeological Region. However, cultural resources there are not as well documented as those around the reservoir. Several inventories have been done in or next to the District (Hughes 1949; Miller 1981; Miller and Crossan 1981; Messerli 1986; Buechler 1986, 1987, 1989; Gonzalez 1989; Vallejo 1989; Quivik and Johnson 1990; Noisat 1992; Kangas 1998). Most investigations, though, were not done in conjunction with projects directly related to operation and maintenance of the irrigation system.

The result is that only a small part of the total District has been inventoried. Only two occupation sites and two historic structures have been identified in or next to the District. The two occupation sites (39FA888 and 39FA714) consist of scatters of prehistoric stone artifacts. Site 39FA888 has been determined not to qualify for NRHP, while there has been no determination on Site 39FA714. The historic structures consist of a cabin (39FA881) and a steel truss bridge (Structure 17-496-252). Both have been determined eligible for inclusion in the NRHP.

Considering the limited inventories in the District, these sites cannot be considered representative of the total number present. Except for Structure 17-496-252, similar types have been recorded in and around the reservoir. Since the District is also next to the Cheyenne River, more complete inventories of the area could be expected to encounter site types and densities comparable to those found around the reservoir.

Reclamation and SHPO are discussing including the canals and laterals for inclusion in NRHP because of its exceptional importance to development of irrigation in the region. Determination has not been completed.

Central Cheyenne Archaeological Region

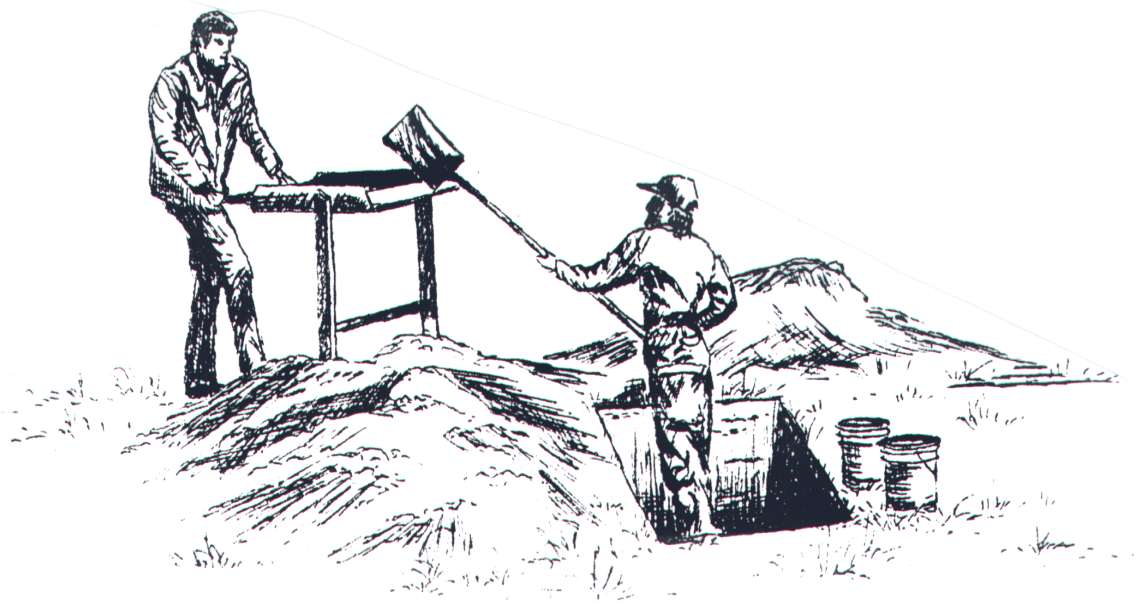
The Central Cheyenne Archaeological Region consists of the Cheyenne River valley and associated terraces, breaks, and nearby plains (Winham and Hannus 1991). The Cheyenne River was a major route linking the Missouri River with the Black Hills. Cherry Creek and Cheyenne City, located at the end of the region, were important centers during the Ghost Dance Movement of the 1880s and 1890s. Several camps along the river have been associated with historic Sioux leaders and elders like Big Foot, Bear Eagle, Red Shirt, Touch the Clouds, Hump, and Corn (Anderson 1956; Winham and

Hannus 1991). All were important in the Ghost Dance Movement and its tragic culmination at the Wounded Knee massacre. Although the region contains several historically significant sites, it has not received the archaeological attention of the South Fork Cheyenne Archaeological Region. The surveys are listed in Appendix X, most of which were small-scale and involved only small acreages.

The earliest systematic inventories were SI-RBS reconnaissance surveys of the area to be inundated by Lake Oahe, including around the mouth of the Cheyenne River. Results of these surveys, though, were poorly reported. In 1988, archaeologists from Augustana College inventoried more than 19,000 acres at the lower end of the river managed by the Corps of Engineers (Winham et al. 1988), representing an expansion of investigations originally done by SI-RBS. This inventory extended into the Central Cheyenne Archaeological Region.

The inventory discovered 79 sites, 10 of which were in the Central Cheyenne Region (Appendix X). Most are in the uplands outside of the Angostura area. Sites include 9 rock cairns, 3 associated lithic artifact scatter, and a lithic scatter. They were recommended as potentially eligible for the NRHP. Winham et al. 1988 also identified 4 previously-reported historic sites, including 3 buildings and 1 school/farmstead. The inventory unfortunately did not include the floodplain of the river, the focus of this EIS.

The most comprehensive inventory was done by SARC (South Dakota Archaeological Research Center) in 1992. It involved an on-the-ground survey of 3,835 acres in selected parts of the river basin and the lower reaches of tributaries (Fosha 1992), including the eastern part of the Central Cheyenne Archaeological Region and the western part of the Bad/Cheyenne Archaeological Region. Most of the inventoried areas are downstream of the EIS area. SARC



recorded 41 sites, 31 in the Central Cheyenne Region. Nine prehistoric site types were encountered, including nine prehistoric occupation sites/artifact scatters, six prehistoric cairn sites, two prehistoric stone circle sites, an historic artifact scatter, a site with both a prehistoric and historic artifact scatter, one historic and three prehistoric isolated finds, a prehistoric hearth, a faunal site, an earthlodge village (the Elmer Briggs Village), four historic farmsteads/cabins, and a site consisting of both a historic farmstead and prehistoric artifact scatter.

The archaeological periods represented by these sites include Middle Archaic, Late Prehistoric, Contact, and Historic. A possible Paleo-Indian occupation may be represented by an isolated hearth and bison bone exposed in a cut bank. The associated landform consists of late Pleistocene or Early Holocene alluvial cut and fill inset on what appears as a Pleistocene terrace. The village site (Elmer Biggs/39HK36) contains 13 circular depressions, 2 stone cairns, 1 stone circle, and 1 metate. Sub-surface probing of a depression revealed burned earth, burned bone, and charcoal. A historic component includes a rectangular stone alignment (assumed to be the foundation of a structure), a cabin, a rectangle depression, and a cistern.

Fosha (1992) recommended that seven of these sites—including the Elmer Briggs Village site—may be eligible for the NRHP. Another two sites were considered ineligible, with eligibility of the remaining twenty-three sites unknown.

Sites types present in the Central Cheyenne River Archaeological Region do not appear to differ substantially from those in the South Fork Cheyenne River Region. The presence of rockshelters in the western part of the South Fork Cheyenne River Archeological Region and their absence in the Central Cheyenne Region may reflect differences in geologic setting. The absence of earthlodge villages in the South Fork Cheyenne River Region may only reflect the lack of surveys there. Further work should produce data necessary for more conclusive comparisons between these two regions and with other nearby regions.

Properties of Traditional Religious and Cultural Importance to Native Americans

The NHPA was amended in 1992 to recognize that sites of religious or cultural importance to Native Americans can qualify as historic properties. Commonly called *Traditional Cultural Properties* (TCPs), these sites often differ from other cultural resource sites because they may often lack physical remains like artifacts, or they may be of recent origin. Such sites are often identified through non-archaeological methods. TCPs are especially critical because of the historic tie between the Lakota and this region of South Dakota. Sundstrom (Sundstrom and Keyser 1984; Sundstrom 1996) has documented the TCPs in the Black Hills and their significance, especially rock art sites. Two rockshelters at Angostura (39FA75 and 39FA91) have petroglyphs and, as such, may constitute TCPs. Consultation with Native American groups could determine whether they are properties of traditional religious and cultural importance and, therefore, qualifying as historic properties.

To assist in identifying TCPs, Reclamation contracted with the OST to interview Tribal elders and traditional leaders. Personal interviews were conducted with individual elder Tribal members who still reside in the area or may have historic or traditional knowledge. These interviews focused on aspects of traditional and historic uses of the Cheyenne River since construction of Angostura Dam.

PALEONTOLOGICAL RESOURCES

Comments were received from the public about effects of the alternatives on paleontological resources, fossil remains of plants and animals, both invertebrate and vertebrate. (Dr. Gordon Bell of the South Dakota School of Mines and Technology's Museum of Geology supplied information used in this section.)

Paleontological resources, like cultural resources, are subject to natural forces such as plant growth, erosion, and slope angle, in addition to human activities. They affect paleontological resources and the ability to locate and identify fossil localities. They can either promote preservation or destruction. For this reason, the area of concern for paleontological resources was the same as for cultural resources: Reclamation-administered lands at the reservoir, the District, and the Cheyenne River downstream from the dam to the west boundary of the Cheyenne River Sioux Reservation. This last area extends to the first terrace (T1) immediately next to the floodplain on both sides of the Cheyenne River. Impacts would be unlikely to extend beyond T1.

Paleontological resources have not received scientific or management attention in the EIS area as have cultural resources. No detailed analysis or summary is available. Few paleontological investigations have been done there, with most of those having being done in conjunction with construction and operation of the dam and reservoir. For this reason, this discussion focuses on data from the dam and reservoir, which is used to evaluate potential for paleontological resources elsewhere in the basin and on possible impacts.

One of the earliest investigations at Angostura was done by SI-RBS in conjunction with construction of the dam and reservoir (Bauxar 1947). The SI-RBS did a preliminary appraisal of paleontological resources to determine if any major finds might be impacted. None were reported.

In 1994, fossilized remains of a mosasaur (*Platecarpus* species.) were discovered eroding out of the Sharon Springs Member of the Pierre Shale at the southern end of the reservoir, overlooking Horsehead Creek. The Museum of Geology, South Dakota School of Mines and Technology, evaluated the remains, which consisted of a single vertebrae, several ribs, the proximal part of the right forelimb, and the pectoral girdle. Exposure caused the bone material to be in poor condition, being soft and powdery (Bell 1995a). No further work was recommended on the fossil.

Spurred by this discovery, Reclamation signed a contract with the Museum to appraise the paleontological resources at the reservoir (Bell 1995b). The appraisal involved a review of existing data, a preliminary field assessment of specific locations considered likely to contain fossils, and a discussion of the geological strata around the reservoir in relation to potential to contain significant fossils.

During the field check, the remains of a Plesiosaur (*Bracaunchenius* species) and a teleost fish (*Pachyrhizodus leptopsis*) were found at the southern end of the reservoir, overlooking the confluence of Horsehead Creek and the Cheyenne River. The remains were excavated in 1996 (Bell 1997). The Plesiosaur remains consist of a well preserved skull, one of less than six reported specimens with cranial material (Bell 1997). The remains of the teleost consist of 5-10 vertebrae, many fin rays and fragments, and a few unidentifiable elements.

No investigations have been done in the District, although Bishop (1981) discussed several fossil localities in the general vicinity. These were outcrops of Pierre Shale that contain decapod crustaceans, specifically those typical of the *Dakoticancer* assemblage. These deposits also date to the Cretaceous Period.

Table 3.39: Geologic Formations and Potential for Paleontological Resources

	Formation (oldest to youngest)	Member	Fossil Potential
Cretaceous Period Deposits	Unkpapa Sandstone		Very low to none. No reported occurrences
	Lakota Formation	Chilson Minnewasta Limestone Fuson	Low. Reported occurrences Low. Reported occurrences Low. Reported occurrences
	Fall River Formation		Low. Some report occurrences
	Skull Creek Shale		Low. One reported occurrence
	Mowry Shale		Moderate. Reported occurrences
	Belle Fourche Shale		High. Reported occurrences
	Greenhorn Limestone		High. Reported occurrences
	Carlile Shale	Pool Creek Turner Sandy Sage Breaks	High. Reported occurrences High. Reported occurrences High. Reported occurrences
	Niobrara Formation		High. Reported occurrences
	Pierre Shale	Gammom Ferruginous Sharon Springs Mitten Black	Very high. Reported occurrences Very high. Reported occurrences Very high. Reported occurrences
	Chadron Formation		High. Reported occurrences
	Brule Formation		High. Reported occurrences
	Sharps Formation		High. Reported occurrences
Quaternary	Quaternary Deposits		Low to moderate. Reported occurrences

Greis (1996) wrote a general summary of South Dakota geology, including the Cheyenne River basin. His summary of basin the parallels that of Bell (1995b) for the reservoir area in that Cretaceous sandstones, shale, limestones, clays, and chalk dominate both the Angostura area and the Cheyenne River basin. Table 3.39 summarizes Bell's review and assesses potential of each geological formation to contain paleontological resources.

Cretaceous sediments, which date to 145-66 million years ago, are the dominant fossil-bearing units. The Cretaceous is a relatively recent geologic period, erosion having had less effect than earlier periods (Thompson 1982). During the period, an inland sea extended from the Gulf of Mexico to the Arctic Ocean inundating most of the Great Plains, including South Dakota. Hence fossil-bearing units around the reservoir date to the Cretaceous. These sediments contain remains of marine invertebrates, mollusks, marine reptiles, flying reptiles (pterosaurs), and rare dinosaurs. More recent fossil-bearing strata date to the Quaternary period, consisting primarily of gravel deposits with petrified wood and cycads (tree ferns).

The formations with the least potential for paleontological resources include the Unkpapa Sandstone, Lakota Formation, Fall River Formation, and Skull Creek Shale. No fossils have been identified in the Unkpapa; the Lakota and Fall River formations have yielded fossilized wood, clams, dinosaur bones, and primitive plants.

Formations with low-moderate potential include Mowry Shale and deposits from the Quaternary Period. The Mowry Shale contains invertebrate and vertebrate marine fossils, including teleost fish, sharks, sawfish, plesiousaurs, and ichthyosaurs. Quaternary deposits are unconsolidated sand, silt and gravel deposited on the floodplain of the Cheyenne River.

Fossils associated with these deposits are large vertebrates, petrified wood, and cycads.

Formations with the highest potential include Belle Fourche Shale, Greenhorn Limestone, Carlile Shale, Niobrara Formation, Pierre Shale, Chadron, Brule, and Sharps. Fossils in these formations are oyster, clam, shark, teleost fish, chimaerid fish, sawfish, turtle, plesiosaur, pterosaur, dinosaur, mosasaur, ammonite, birds and wood.